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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/743,982	01/18/2001	Takao Abe	108360	1567

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EXAMINER

ANDERSON, MATTHEW A

ART UNIT	PAPER NUMBER
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1765

DATE MAILED: 07/31/2002

7

Please find below and/or attached an Office communication concerning this application or proceeding.

8W

Office Action Summary

Application No.

09/743,982

Applicant(s)

ABE ET AL.

Examiner

Matthew A. Anderson

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 16 February 2001.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 20-42 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 20-42 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 01 February 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
- 11) ☐ The proposed drawing correction filed on _____ is: a) ☐ approved b) ☐ disapproved by the Examiner.
If approved, corrected drawings are required in reply to this Office action.
- 12) ☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

- 13) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
* See the attached detailed Office action for a list of the certified copies not received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).
a) ☐ The translation of the foreign language provisional application has been received.
- 15) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892) 4) ☐ Interview Summary (PTO-413) Paper No(s) _____
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948) 5) ☐ Notice of Informal Patent Application (PTO-152)
- 3) ☒ Information Disclosure Statement(s) (PTO-1449) Paper No(s) 4 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claim 20 is rejected under 35 U.S.C. 102(b) as being anticipated by Izunome et al. (US 5,700,320).

Izunome et al. discloses the production of single crystalline Si which is doped with gallium and either B or P by the Cz method. In col. 3 lines 25-35 the resistance of the melt is optimized to be 0.001-10 Ω -cm by the addition of Ga. This also is described as the addition of 1×10^{18} - 5×10^{20} atoms /cm³ of Ga to the melt accounting for evaporation loss from the melt during the pulling process.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

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4. Claims 21-32, 37-42 are rejected under 35 U.S.C. 103(a) as being unpatentable over Izunome et al. as applied to claim 1 above, and further in view of Wolf et al.

(Silicon Processing for the VLSI Era Volume 1: Processing Technology, Lattice Press, Sunset Beach, CA, USA, pp. 1-35, 1986.), Ravi et al. (US 4152536), and Minahan et al. (Conf. Rec. IEEE Photovoltaic Spec Conf. (1982), 16th, 310-15).

Izunome et al. is described above.

Izunome et al. does not disclose further uses, properties, and methods (other than the basic Cz crystal pulling technique) of forming doped Si single crystals.

Wolf et al. discloses the known technology of silicon single crystal formation and doping. Typical interstitial oxygen concentrations in Cz-Si are given as 5×10^{17} - 1×10^{18} atoms /cm³ on page 16. Diameters for typical Cz-Si wafers formed from single crystal ingots are given as up to 200mm (~8 inches). Formation of wafers from Si single crystal ingots by slicing is disclosed on page 23.

Ravi et al. discloses one known use of single crystal Si to be for solar cells and that the best conversion efficiency is derived from p or n type doped regions with a resistance of from 0.001-10 Ω -cm.

Minahan et al. discloses (see abstract) that Cz-Si wafers doped with Ga are useful in solar cells.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to combine the above references because the known use of Ga-Cz Si wafers as solar cell components and expected properties for such solar cells is thus deduced. Motivation for the combination is found in that the expected properties of the

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solar cells formed from Ga doped Si are useful for predicting the cells commercial viability.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to optimize the concentration of the Ga dopant in a Cz-Si single crystal because Izunome et al. suggests this effects the resistance of the melt and thus the resistance of the single crystal grown from that melt.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to expect Cz-Si to have a interstitial oxygen concentration of less than 2.0×10^{18} atoms/cm³ or less because such is described as a typical range for Cz-Si by Wolf et al. and Wolf et al. discloses the need to at least monitor the property.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to grow ingots at least 4 inches and to form wafers by slicing the ingot formed by Cz pulling because such products and methods are described by Wolf et al.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use Ga doped silicon single crystal and the wafers sliced therefrom as material for a solar cell because such is suggested by Minahan et al.

It would have been obvious to optimize the area of a solar cell produced from such doped Si because a larger area means more light collection surface and thus more electron flow and because the known Si-wafer diameters from Wolf et al. (at least the 6 in and 8 in sizes) would have provided at least this much area.

One of ordinary skill in the art would have expected a high conversion efficiency in a Ga doped Cz-Si single crystal with the resistivity of between 0.1 Ω -cm and 5 Ω -cm because such is suggested by Ravi et al. combined with Izunome.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use a Si solar cell in space from news releases about the International Space Station, Minahan et al.'s disclosure of the measurement and analysis of radiation resistance in various Si solar cells, and because such a cell would have been anticipated to produce an expected result.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to use the Cz method of pulling Ga doped Si single crystals using a seed dipped into a melt because such is suggested by the combination of Izunome et al. and Wolf et al.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to dope the melt by charging the crucible with a single crystal highly doped with Ga with Si and forming a melt therefrom because such is suggested by Wolf et al. on page 12, 2nd paragraph.

It would have been obvious to one of ordinary skill in the art at the time of the present invention to optimize the rotation rate of the crucible because such rotation was described by Wolf et al. on page 15 to effect the chemical uniformity and thermal symmetry, such optimization would have been anticipated to produce an expected result of a more uniform melt, and such optimization would have been achieved with only routine experimentation.

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It would have been obvious to one of ordinary skill in the art at the time of the present invention to optimize the pressure during the Cz grown process and the amount of gas flowed through the pulling apparatus because Wolf et al. discloses reduced pressure during growth for reducing evaporation from the melt and the control of argon gas flow (page 18 with argon gas shown in Fig. 14), such optimization would have been achieved with only routine experimentation, and would have been anticipated to produce a Cz-Si ingot.

Claim Rejections - 35 USC § 112

5. Claims 33-36 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The claim to a rate described by a percent only is indefinite. A rate implies a change in a parameter per unit time.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew A. Anderson whose telephone number is (703) 308-0086. The examiner can normally be reached on M-Th, 6:30-5.


If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin Utech can be reached on (703) 308-3836. The fax phone

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numbers for the organization where this application or proceeding is assigned are (703) 872-9310 for regular communications and (703) 872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0661.

MAA
July 24, 2002


BENJAMIN L. UTECH
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